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Dated 13 January 2004

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APPLICANT: Ian S. BREAKWELL et al.
APPLICATION NO.: New U.S. Application
FILED: January 23, 2004
FOR: A GAS TURBINE ENGINE NOSE CONE
ATTORNEY DOCKET NO.: 118450

Patents Form 7/77

Patents Act 1977
(Rule 15)

THE PATENT OFFICE
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Statement of inventorship and of right to grant of a patent

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1. Your reference DY 3091

2. Patent application number *(if you know it)* 0303569.8

3. Full name of the or of each applicant ROLLS-ROYCE plc

4. Title of the invention
A GAS TURBINE ENGINE NOSE CONE

5. State how the applicant *(s)* derived the right from the inventor *(s)* to be granted a patent
BY VIRTUE OF AN ASSIGNMENT DATED 6 FEBRUARY 2003

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7. I/We believe that the person *(s)* named over the page *(and on any extra copies of this form)* is/are the inventor *(s)* of the invention which the above patent application relates to.

Signature M A GUNN Date 13 FEBRUARY 2003

8. Name and daytime telephone number of person to contact in the United Kingdom
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Notes

a) If you need help to fill in this form or you have any questions, please contact the Patent Office on 08459 500505.

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Enter the full names, addresses and postcodes of the inventors in the boxes and underline the surnames

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Patents ADP number *(if you know it)*: 8566945001

Patents ADP number *(if you know it)*:

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17FEB03 E785530-1 000370
P01/7700 0.00-0303569.8

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The Patent Office

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1. Your reference DY 3091

2. Patent application number
(The Patent Office will fill in this part) 0303569.8

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

ROLLS-ROYCE plc
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GREAT BRITAIN

Patents ADP number *(if you know it)*

If the applicant is a corporate body, give the country/state of its incorporation GREAT BRITAIN

8504375001

4. Title of the invention A GAS TURBINE ENGINE NOSE CONE

5. Name of your agent *(if you have one)*

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

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Patents ADP number *(if you know it)* 396003

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Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

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a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body.
See note (d))

YES

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Continuation sheets of this form	0
Description	6
Claim(s)	2
Abstract	1
Drawing(s)	2 + 2

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Priority documents	0
Translations of priority documents	0
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	YES
Request for preliminary examination and search *(Patents Form 9/77)*	YES
Request for substantive examination *(Patents Form 10/77)*	YES
Any other documents *(please specify)*	NO

11. I/We request the grant of a patent on the basis of this application.

Signature M A GUNN

Date 13 FEBRUARY 2002

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DUPLICATE

A GAS TURBINE ENGINE NOSE CONE

The present invention relates to a gas turbine engine nose cone, particularly a turbofan gas turbine engine nose cone.

It is known from EP1016588A to provide a gas turbine engine nose cone comprising a spinner having a generally conical upstream portion and a generally cylindrical base portion having a flange removably connected to a fan hub of the gas turbine engine. A frustoconical fairing surrounds the base portion of the spinner and the outer surface of the fairing forms a continuation of the outer surface of the conical upstream portion of the spinner.

It is known from GB2011542A to provide a skin on the outer surface of a gas turbine engine nose cone to protect the nose cone from erosion.

A protective skin has been provided on the outer surface of a fairing of a nose cone comprising a spinner and a fairing, as discussed above. However, the fairing suffers from stripping of the protective skin from the upstream edge of the fairing in operation due to erosion. The protective skin peels off the fairing from the upstream end towards the downstream end in operation of the gas turbine engine due to centrifugal force.

It is known from EP1227036A to provide a circumferentially extending protective member extending around the upstream end of the fairing to retain the protective skin on the upstream end of the fairing. The protective skin for example comprises a polyurethane coating and the protective member comprises a silicone elastomer. The protective member is adhesively bonded to the fairing and the protective skin.

However, it has been found that there is insufficient adhesion between the protective member and the protective skin, which may lead to the protective member becoming detached from

the protective coating. Also, the protective skin has insufficient thickness at the upstream end of the fairing.

Accordingly the present invention seeks to provide a novel gas turbine engine nose cone which reduces, preferably overcomes, the above mentioned problems.

Accordingly the present invention provides a gas turbine engine nose cone comprising a spinner having a generally tapering upstream portion and a generally cylindrical base portion, the cylindrical base portion having a flange removably connected to a fan hub of the gas turbine engine, a tapering fairing surrounding the base portion of the spinner, the outer surface of the fairing forms a continuation of the outer surface of the tapering upstream portion of the spinner, a circumferentially extending fibrous material extending around the upstream end of the fairing, the outer surface of the fairing having a skin to protect the fairing from erosion, the skin extending around the upstream end of the fairing and being infiltrated into the fibrous material to form a composite material and to bond the skin to the upstream end of the fairing.

Preferably the skin comprises polyurethane.

Preferably a radially inner portion of the fibrous material locates in an annular groove on the radially inner surface of the upstream end of the fairing.

Preferably the circumferentially extending fibrous material is bonded to the upstream end of the fairing.

Preferably the fairing comprises a fibre-reinforced material. Preferably the spinner comprises a fibre-reinforced material. Preferably the fairing comprises a radially inwardly extending lip to form a seal between the upstream end of the fairing and the spinner.

The present invention will be more fully described by way of example with reference to the accompanying drawings in which:-

Figure 1 shows a turbofan gas turbine engine comprising a gas turbine engine nose cone according to the present invention.

Figure 2 is an enlarged cross-sectional view of the gas turbine engine nose cone shown in figure 1.

Figure 3 is a further enlarged cross-sectional view of part of the gas turbine engine nose cone shown in figure 2.

A turbofan gas turbine engine 10, as shown in figure 1, comprises in axial flow series an inlet 12, a fan section 14, a compressor section 16, a combustion section 18, a turbine section 20 and an exhaust nozzle 22. The turbine section 18 comprises a low pressure turbine (not shown) arranged to drive the fan section 14 via a shaft (not shown). The turbine section 18 also comprises a high pressure turbine (not shown) arranged to drive a high-pressure compressor (not shown) in the compressor section 14 via a shaft (not shown). The turbine section 18 may also comprise an intermediate pressure turbine (not shown) arranged to drive an intermediate pressure compressor (not shown) in the compressor section 14 via a shaft (not shown). The turbofan gas turbine engine 10 operates quite conventionally and its operation will not be discussed further.

The fan section 14 comprises a fan rotor 24 carrying a plurality of circumferentially spaced radially outwardly extending fan blades 26. The fan rotor 24 and fan blades 26 are surrounded by a fan casing 28 which partially defines a fan duct 30. The fan casing 28 is secured to a core casing 32 by a plurality of circumferentially spaced and radially extending fan outlet guide vanes 34. The fan duct 30 has a fan outlet 36 at its downstream end.

The fan rotor 24 comprises a fan disc 38 and a nose cone 40, as shown more clearly in figure 2. The fan blades 26 and nose cone 40 are mounted on the fan disc 38. The nose cone 40 is generally of a tapering shape with a point at the upstream end 42 and a circular base portion at the downstream end 44. The nose cone 40 may be either conical, dome shaped or any other

suitable shape. The nose cone 40 comprises a spinner 46 and a fairing 48.

The spinner 46 comprises a tapering upstream portion 50 and a generally cylindrical base portion 52. The cylindrical base portion 52 comprises a radially outwardly extending flange 54 which is removably connected to the fan disc 38. The tapering upstream portion 50 is preferably conical, but may be dome shaped or other suitable shapes. The tapering upstream portion 50 of the spinner 46 has an outer surface 56. The cylindrical base portion 52 is connected to the fan disc 38 by fasteners, for example bolts 58 and nuts 60. The bolts 58 extend axially through apertures 62 in the flange 54 and apertures 66 in a radially outwardly extending flange 64 on the fan disc 38. The spinner 46 preferably comprises a fibre-reinforced material, but may comprise titanium or other suitable lightweight material.

The fairing 48 tapers and surrounds the base portion 52 of the spinner 46. The outer surface 68 of the fairing 48 forms a continuation of the outer surface 56 of the tapering upstream portion 50 of the spinner 46. The fairing 48 is preferably frustoconical, but other suitable shapes may be used. The fairing 48 is removably connected to the fan disc 38 by a number of circumferentially spaced L-shaped brackets 70. Each L-shaped bracket 70 is secured to the fairing 38 by fasteners, for example bolts 72 and nuts 74. The bolts 72 extend radially through apertures 76 in the fairing 48 and apertures 78 in the L-shaped brackets 70. The bolts 72 have conical heads and the apertures 76 are countersunk. The fairing 48 preferably comprises a fibre-reinforced material, but may comprise titanium or other suitable lightweight material.

A skin 80 is provided on the outer surface 68 of the fairing 48 to protect the fairing 48 from erosion from particles entering the inlet 12 of the turbofan gas turbine engine 10. Preferably the skin 80 comprises polyurethane, but may comprise other suitable materials. The skin 80 extends from the upstream

end 82 to the downstream end 84 of the fairing 48 and the skin 80 also extends around the upstream end 82 of the fairing 48 into an annular groove 90 on the radially inner surface 92 at the upstream end 82 of the fairing 48. The skin 80 extends circumferentially through the full extent of the fairing 48.

A fibrous material 86 extends around the upstream end 82 of the fairing 48 to retain the skin 80 on the upstream end 82 of the fairing 48 and the fibrous material 86 is incorporated into the skin 80 at the upstream end 82 of the fairing 48. The fibrous material 86 reinforces the skin 80 and bonds the skin 80 to the upstream end 82 of the fairing 48, as shown more clearly in figure 3. The fibrous material 86 extends circumferentially through the full extent of the fairing 48. A radially inner portion 88 of the fibrous material 86 locates in the annular groove 90 on the radially inner surface 92 at the upstream end 82 of the fairing 48. An adhesive 94 is used to bond the fibrous material 86 into the annular groove 90 at the upstream end 82 of the fairing 48 and to the outer surface 68 of the fairing 48 at the upstream end 82 of the fairing 48. The fibrous material 86 preferably comprises a fabric of fibres, for example knitted or woven fibres. The fibres are polyester fibres, but glass fibres or other suitable fibres may be used. The adhesive 94 comprises silcoset (trade name), or an adhesive 3145 supplied by Dow Corning, but may comprise any other suitable adhesive.

The fibrous material 86 is bonded to the upstream end 82 of the fairing 48 before the skin 80 is applied to the outer surface 68 and upstream end 82 of the fairing 48. The skin 80 is applied onto the outer surface 68 of the fairing 48 and to the fibrous material 86. The skin 80 infiltrates, soaks, into the fibrous material 86 to form a composite material at the upstream end 82 of the fairing 48 and the fibrous material 86 bonds the skin 80 to the upstream end 82 of the fairing 48 and enables a skin 80 of sufficient thickness to be produced at the

upstream end 82 of the fairing 48. The fibrous material 86 provides a sufficiently large radius of curvature for the skin 80 to adhere to.

In operation the fibrous material 86 reinforces the skin 80, increases the thickness of the skin 80, bonds the skin 80 to upstream end 82 of the fairing 48 and provides greater erosion resistance to the particles that enter the inlet 12 of the turbofan gas turbine engine 10 and impact on the leading edge of the fairing 48 to reduce lifting of the skin 80 away from the leading edge 82 of the fairing 48. This ensures that the centrifugal force on the fairing 48 and skin 80 does not lead to the subsequent peeling of the skin 80 away from the fairing 48. The fairing 48 is protected from erosion for longer periods of time before a new skin 80 has to be provided on the fairing 80.

The spinner 46 may also be provided with a skin to protect against erosion from particles entering the inlet 12 of the gas turbine engine 10.

CLAIMS

1. A gas turbine engine nose cone comprising a spinner having a generally tapering upstream portion and a generally cylindrical base portion, the cylindrical base portion having a flange removably connected to a fan hub of the gas turbine engine, a tapering fairing surrounding the base portion of the spinner, the outer surface of the fairing forms a continuation of the outer surface of the tapering upstream portion of the spinner, a circumferentially extending fibrous material extending around the upstream end of the fairing, the outer surface of the fairing having a skin to protect the fairing from erosion, the skin extending around the upstream end of the fairing and being infiltrated into the fibrous material to form a composite material and to bond the skin to the upstream end of the fairing.

2. A gas turbine engine nose cone as claimed in claim 1 wherein the skin comprises polyurethane.

3. A gas turbine engine nose cone as claimed in claim 1 or claim 2 wherein the circumferentially extending fibrous material comprises woven fibres or knitted fibres.

4. A gas turbine engine nose cone as claimed in claim 1, claim 2 or claim 3 wherein a radially inner portion of the circumferentially extending fibrous material locates in an annular groove on the radially inner surface of the upstream end of the fairing.

5. A gas turbine engine nose cone as claimed in claim 4 wherein the circumferentially extending fibrous material is bonded to the upstream end of the fairing.

6. A gas turbine engine nose cone as claimed in any of claims 1 to 5 wherein the fairing comprises a fibre-reinforced material.

7. A gas turbine engine nose cone as claimed in any of claims 1 to 6 wherein the spinner comprises a fibre-reinforced material.

8. A gas turbine engine nose cone as claimed in any of claims 1 to 7 wherein a radially inner portion of the skin locates in the annular groove on the radially inner surface of the upstream end of the fairing.

9. A gas turbine engine nose cone as claimed in any of claims 1 to 8 wherein the fibrous material comprises glass fibres or polyester fibres.

10. A gas turbine engine nose cone substantially as hereinbefore described with reference to figures 1, 2 and 3 of the accompanying drawings.

ABSTRACT

A GAS TURBINE ENGINE NOSE CONE

A gas turbine engine nose cone (44) comprises a spinner (46) and a fairing (48). The spinner (46) has a conical upstream portion (50) and a cylindrical base portion (52). The fairing (48) is frustoconical and surrounds the base portion (52) of the spinner (46). The outer surface (68) of the fairing (48) forms a continuation of the outer surface (56) of the conical upstream portion (50) of the spinner (46). A fibrous material (86) extends around the upstream end (82) of the fairing (48). The outer surface (68) of the fairing (48) has a skin (80) to protect the fairing (48) from erosion. The skin (80) extends around the upstream end (82) of the fairing (48) and is infiltrated into the fibrous material (86) to form a composite material and to bond the skin (80) to the upstream end (82) of the fairing (48).

(Figure 3)

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Fig.1.

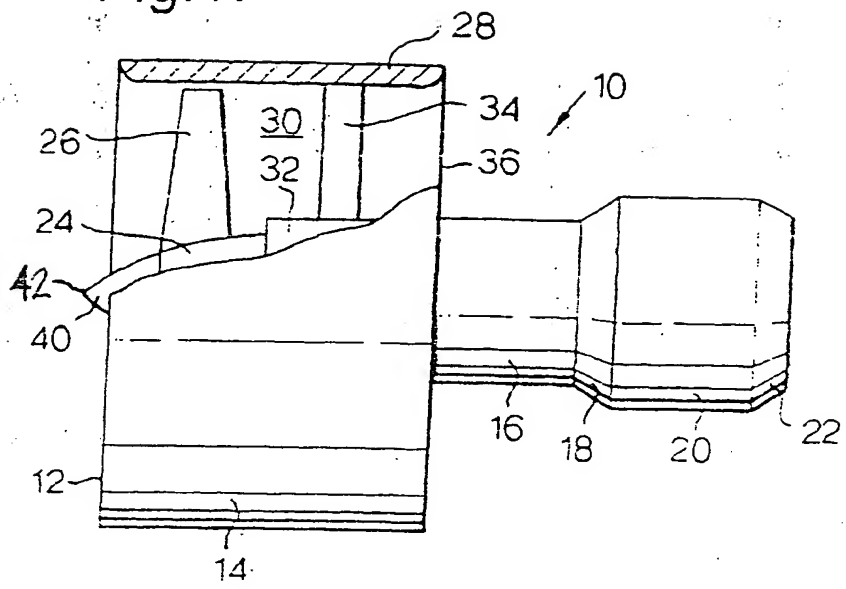
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Fig.3.

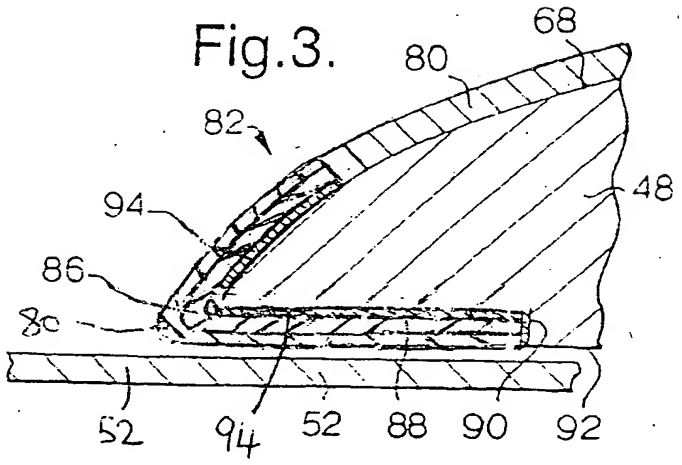
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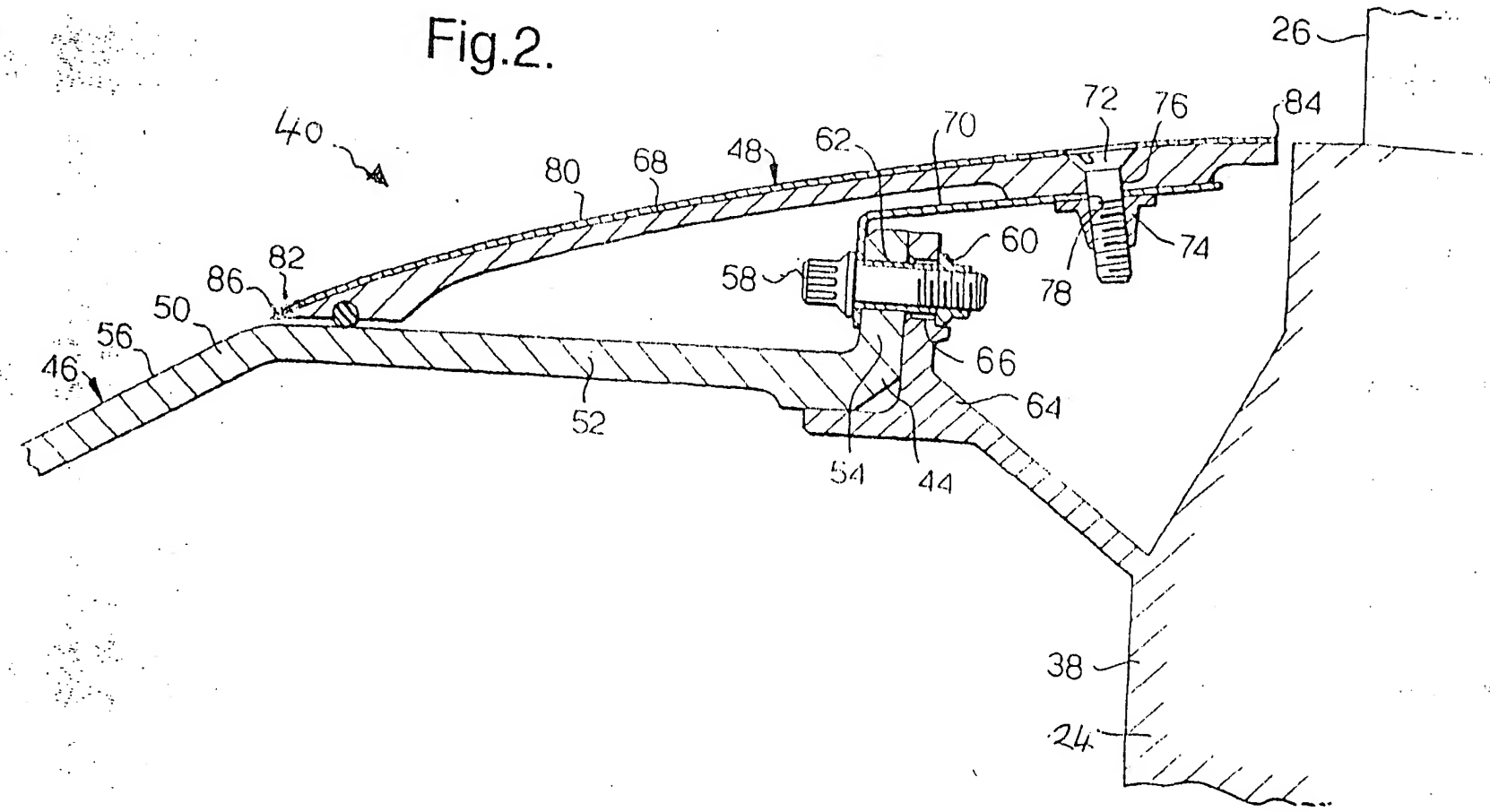
Fig.2.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